F
1435
.3
C14B59

BOWDITCH

METHOD WHICH MAY HAVE BEEN USED

BANCROFT
LIBRARY

The Bancroft Library
University Library
University of California · Berkeley

Digitized by the Internet Archive
in 2007 with funding from
Microsoft Corporation

http://www.archive.org/details/methodwhichmayha00bowdrich

A METHOD WHICH MAY HAVE BEEN USED BY THE MAYAS IN CALCULATING TIME

BY

CHARLES P. BOWDITCH

CAMBRIDGE
THE UNIVERSITY PRESS
1901

A METHOD WHICH MAY HAVE BEEN USED BY THE MAYAS IN CALCULATING TIME

BY

CHARLES P. BOWDITCH

CAMBRIDGE
THE UNIVERSITY PRESS
1901

THE BANCROFT LIBRARY

F1435
.3
C14B59

A METHOD WHICH MAY HAVE BEEN USED BY THE MAYAS IN CALCULATING TIME

By CHARLES P. BOWDITCH

It is now considered settled that the Initial Series, so-called, of the Maya inscriptions had for the basis of the long count a day 4 Ahau 8 Cumhu, and that in almost all cases by counting forward from that day the number of days as given in the long count, the day and month is reached which is given in the glyphs following the period glyphs.

One method which has been used by Americanists for calculating the position of this day and month in the Maya calendar is as follows:

Calculate the number of days as given in the long count.

Divide the result by 13, and add the remainder to 4, in order to find the number attached to the day sign.

Divide the result by 20 and count forward the remainder from Ahau, in order to find the day. This can of course be simplified by merely counting forward from Ahau the number attached to the kin sign, since all the other periods are exactly divisible by 20.

Divide the result by 365 and count forward the remainder from 8 Cumhu, in order to find the day of the month, and month.

An example is given from Stela 25 of Piedras Negras. Here the Initial Series is (using Goodman's notation) 54.9.8.10.6.16., 10 Cib 9 Mac. This period will then be

$$
\begin{aligned}
9 \times 144{,}000 &= 1{,}296{,}000 \\
8 \times 7{,}200 &= 57{,}600 \\
10 \times 360 &= 3{,}600 \\
6 \times 20 &= 120 \\
16 \times 1 &= 16 \\
&\overline{1{,}357{,}336}
\end{aligned}
$$

$$
\begin{aligned}
1{,}357{,}336 &= 13 \times 104{,}410 + 6 \qquad 6 + 4 = 10 \\
&= 20 \times 67{,}866 + 16 \qquad \text{Ahau} + 16 = \text{Cib.} \\
&= 365 \times 3{,}718 + 266 \qquad 8\ \text{Cumhu} + 266 = 9\ \text{Mac.}
\end{aligned}
$$

THE SMITHSONIAN LIBRARY

This is a very tedious method and has been simplified by the Tables of Goodman and Gates; but there is nothing to show that the Mayas had such Tables or that they adopted such a long process in order to reach their results. We do not know that they were able to perform long division, and even if they knew how to accomplish this feat, it could not have failed to have been a very complicated matter with their vigesimal system, especially as this system was not regular in the uinal term. Such divisions as 1,357,336 by 365, for instance, would have been avoided in all probability if a simpler way could have been found. The following method is suggested as one which may have been in use among them. I use the plus sign to mean "count forward" and the minus sign to mean "count backward."

1°. *To find the number attached to the day sign.*

To the number attached to the cycle sign, add twice the number attached to the katun sign and four times the number attached to the tun sign, giving the sum the minus sign.

To seven times the number attached to the uinal sign, add the number attached to the kin sign, giving this sum the plus sign.

Add these sums together, adding the result to 4 (of 4 Ahau) if the sign is plus, or subtracting it from 4 if the sign is minus. In the first case subtract as many times 13 as possible from the last sum. In the second case, add to 4 as many times 13 as are needed to make it larger than the number to be subtracted from it. The result is the number attached to the day sign sought for.

2°. *To find the day sign.*

Count forward from Ahau the number of days equal to the number attached to the kin sign. The result is the day sign sought for.

3°. *To find the month and month number.*

Give the plus sign to the long count.

Give the minus sign to the cycle, katun, and tun count of 9.9.16.

Add the two together and give the sum the proper sign.

Multiply the resulting katun number by 100 and the tun number by 5, add the two products, and give the sum the sign opposite to the resulting sign.

Multiply the resulting uinal number by 20 and to the product add the kin sign, giving the sum the sign as given.

Add the last two sums together, giving the final sum the proper sign, and after deducting as many times 365 as possible count backwards or forwards the remainder from 8 Cumhu according to the sign.

It is not impossible that this is the method suggested on page 24 of the Dresden Codex.

For 3°, the following method can be substituted, which is somewhat simpler in the use of the plus and minus signs.

3° (*bis*).

Give the minus sign to the long count, omitting the uinals and kins.

Give the plus sign to the cycle, katun, and tun count of 9.9.16.

Add the two together and give the sum the proper sign.

Multiply the katun number of this sum by 100 and the tun number by 5 and add them together with the proper sign.

Multiply the uinal of the long count by 20 and add the product to the kin number with the plus sign.

Add these last two sums together with the proper sign.

After deducting as many times 365 as possible from this last sum, count backwards or forwards the remainder from 8 Cumhu according to the sign.

I give here three examples from the Inscriptions of these methods of calculation.

Stela 25 of Piedras Negras has the Initial Series 54.9.8.10.6.16., 10 Cib 9 Mac.

1°. $9 \times 1 = 9$ $\quad 6 \times 7 = 42$
$8 \times 2 = 16$ $\quad 16$
$10 \times 4 = 40$
-65 $\quad +58$
$+58$
-7
$4 + 13 = 17 - 7 =$ 10
2°. Ahau $+ 16 =$ Cib.
3°. $-$ 9.9.16.0. 0.
$+$ 9.8.10.6.16.
$-$ 1. 5.11.4.
$1 \times 100 = +100$
$5 \times 5 = +25$ $\quad +125$
$11 \times 20 = -220$
-4 $\quad -224$
-99
8 Cumhu $-99 =$ 9 Mac.
3° (*bis*).
$+$ 9.9.16.
$-$ 9.8.10.
$+$ 1. 6
$1 \times 100 = +100$ $\quad 6 \times 20 = +120$
$6 \times 5 = +30$ $\quad +16$
$+130$ $\quad +136$
$+136$
$+266$
8 Cumhu $+ 266 =$ 9 Mac.

Stela 36 of Piedras Negras has the Initial Series 54.9.10.6.5.9., 8 Muluc 2 Zip.

1°. $9 \times 1 = 9$ $\quad 5 \times 7 = 35$
$10 \times 2 = 20$ $\quad 9$
$6 \times 4 = 24$
-53 $\quad +44$
$+44$
-9
$4 + 13 = 17 - 9 =$ 8

2°. Ahau + 9 = Muluc.
3°. − 9. 9.16.0.0.
+ 9.10. 6.5.9.
+ 10.5.9.
10 × 5 = − 50
5 × 20 = + 100
+ 9 + 109
+ 59

8 Cumhu + 59 = 2 Zip.
3° (*bis*).
+ 9. 9.16.
− 9.10. 6.
− 0.10.
10 × 5 = − 50
5 × 20 = + 100
+ 9 + 109
+ 59 as before.

On Stela B. of Copan is the Initial Series 54.9.15.0.0.0., 4 Ahau 13 Yax.

1°. 9 × 1 = 9
15 × 2 = 30
− 39 4 + (3 × 13) = 43 − 39 = 4
2°. Ahau + 0 = Ahau.
3°. + 9.15. 0.0.0.
− 9. 9.16.0.0.
+ 5. 4.0.0.
5 × 100 = − 500
4 × 5 = − 20
− 520
365
− 155

8 Cumhu − 155 = 13 Yax.
3° (*bis*).
− 9.15. 0.
+ 9. 9.16.
− 5. 4.
5 × 100 = − 500 etc. as before.

All these calculations can easily be done in the head, and the

principle can be applied to smaller numbers than those found in the Initial Series.

It may be well to add here a fourth example from page 24 of the Dresden Codex. Here we have the two long counts

9.9.16. 0.0.
9.9. 9.16.0.

Taking the latter count, we find

1°.	9 × 1 = 9	16 × 7 = + 112	
	9 × 2 = 18		
	9 × 4 = 36		
	— 63		
	+ 112		
	+ 49		
(3 × 13)	39		
	+ 10	4 + 10 = 14 − 13 =	1
2°.	Ahau + 0 =		Ahau.
3°.	— 9.9.16. 0.0.	(found on page 24)	
	+ 9.9. 9.16.0.	" "	
	— 6. 2.0.	" "	
	6 × 5 = + 30		
	2 × 20 = — 40		
	— 10	8 Cumhu — 10 =	18 Kayab.

and 1 Ahau 18 Kayab is found under the second column from the left.

3° (*bis*).

	+ 9.9.16. 0.0.
	— 9.9. 9.
	+ 7.
7 × 5 =	+ 35
16 × 20 =	+ 320
	+ 355

8 Cumhu + 355 = 18 Kayab as before.

The reason why these results are produced is not far to seek.

1°. Each cycle consists of 144,000 days. This number is divisible by 13 with a remainder of 12. If then we count forward one cycle from a given day, say 4 Ahau, the number of the day will be $4 + 12 = 16 - 13 = 3$. The same result will be produced, if, instead of adding 12, we should subtract 1. To find the day-number after adding two cycles, we must add twice 12 or subtract twice 1, and so on for any number of cycles.

In the same way a katun is 7200 days. This number is divisible by 13 with a remainder of 11. If then we wish to count forward a katun from a given day, we can find the number of that day by adding 11 or by subtracting 2. And so on for any number of katuns.

The 360 days of a tun is divisible by 13 with a remainder of 9. If we wish to count forward from a given day one tun, we shall find the number of the day sought by adding 9 to the number of the given day or by subtracting 4. And so for any number of tuns. In each of these three cases we subtract, so that we may use smaller numbers in our calculations.

But with the uinal, we find that 20 is divisible by 13 with a remainder of 7. So in counting forward one uinal, we can add 7 or subtract 6. There is not much choice here, and so we choose to add, as we do also with the kin number.

2°. As has been already explained, the day sought is found by counting forward the number of the kin sign from the day started from, because all the other period numbers are divisible by 20, the number of days in a day round.

3°. Here our object is to count forward the number of days given in the Initial Series. But in order to bring this count to lower terms without altering its value, we subtract (or give the minus sign to) a period of 72 calendar rounds, or 9.9.16., wherever, as is almost always the case in the Initial Series, the cycle number is a 9. Such a subtraction makes no difference in the final count.

Taking the case of Stela 36 of Piedras Negras, we find the first sum to be + 10.5.9. We have therefore to count forwards 10 tuns, 5 uinals, and 9 kins. Taking up the tuns at first, we can call these ten years, which will bring us to the same month and day of the month with which we started, provided we count back five days for each year. That is we must count back 5 × 10 days or − 50. But we must also count forward the number of days represented by the uinals and kins, which gives

$$\begin{aligned} 5 \times 20 &= + 100 \\ &+ \ 9 \\ &+ 109 \end{aligned}$$

Deducting the 50 days obtained from the tuns, we have a remainder of + 59, which being counted forward from 8 Cumhu, brings us to 2 Zip.

3° (*bis*). Here we have pursued exactly the same method except that we have changed the signs of the long count and of the 9.9.16., in order not to have so much changing of signs in the later calculations.

It should also be said that the count of 9.9.16. is not the only one which can be used in order to bring lower terms into use. Any number of complete calendar rounds will answer the purpose, though, as the count of 9.9.16. is given on page 24 of the Dresden Codex, and as most of the cycle numbers in the Initial Series are 9's, it has been taken as a convenient number. A complete list of calendar rounds from one to eighty, in the notations of cycles, katuns, tuns, and uinals, is given in the Table.

But probably the Mayas would wish to make this long count coincide with the count which is given in the Books of Chilan Balam, where the count is by katuns which are designated as Katun 13 Ahau, Katun 11 Ahau, Katun, 9 Ahau, etc. This is easily done by adding the cycle number to twice the katun number, deducting as many thirteens as possible and subtracting the remainder from 4 or from 4 increased by 13 or a multiple of 13.

Thus in the first example, 54.9.8.10.6.16., we take

$$\begin{aligned} 9 \times 1 &= -\ 9 \\ 8 \times 2 &+ -\ 16 \\ &\quad\ \overline{} \\ &-\ 25 \\ &\quad\ 13 \\ &\quad\ \overline{} \\ &-\ 12 \end{aligned}$$

and $4 + 13 - 12 = 5$, and Katun 5 Ahau is the katun in which this date appears, or, in other words, 5 Ahau is the beginning day of 54.9.8.0.0.0.

Again the second example is 54.9.10.6.5.9. Here we have

$$\begin{aligned} 9 \times 1 &= -\ 9 \\ 10 \times 2 &= -\ 20 \\ &\quad\ \overline{} \\ &-\ 29 \\ \text{Deduct twice thirteen, or} &\quad\ 26 \\ &\quad\ \overline{} \\ &-\ 3. \end{aligned}$$

$4 - 3 = 1$, and Katun 1 Ahau is the katun in which the date appears, or 1 Ahau is the beginning day of 54.9.10.0.0.0.

In the third example we have 54.9.15.0.0.0., and the same calculation brings

$$\begin{aligned} 9 \times 1 &= -\ 9 \\ 15 \times 2 &= -\ 30 \\ &\quad\ \overline{} \\ &-\ 39 \\ \text{Deduct three times thirteen, or} &\quad\ 39 \\ &\quad\ \overline{} \\ &\quad\ 0 \end{aligned}$$

$4 - 0 = 4$, and Katun 4 Ahau is the katun in which this date appears, or 4 Ahau is the beginning day of 54.9.15.0.0.0.

And finally on page 24 of the Dresden Codex, where however there is no large glyph at the beginning of the Series as there is

invariably in the Inscriptions, we have 9.9.9.16.0. Here the calculation is

$9 \times 1 =$	$-\ 9$
$9 \times 2 =$	$-\ 18$
	$-\ 27$
Deduct twice thirteen, or	26
	$-\ 1$

$4 - 1 = 3$, and Katun 3 Ahau is the katun in which this date appears.

TABLE.

Calendar Rounds.	*Days.*	*Cycles, etc.*	*Calendar Rounds.*	*Days.*	*Cycles, etc.*
1	18,980	2.12.13.0.	41	778,180	5. 8. 1.11.0.
2	37,960	5. 5. 8.0.	42	797,160	5.10.14. 6.0.
3	56,940	7.18. 3.0.	43	816,140	5.13. 7. 1.0.
4	75,920	10.10.16.0.	44	835,120	5.15.19.14.0.
5	94,900	13. 3.11.0.	45	854,100	5.18.12. 9.0.
6	113,880	15.16. 6.0.	46	873,080	6. 1. 5. 4.0.
7	132,860	18. 9. 1.0.	47	892,060	6. 3.17.17.0.
8	151,840	1. 1. 1.14.0.	48	911,040	6. 6.10.12.0.
9	170,820	1. 3.14. 9.0.	49	930,020	6. 9 3. 7.0.
10	189,800	1. 6. 7. 4.0.	50	949,000	6.11.16. 2.0.
11	208,780	1. 8.19.17.0.	51	967,980	6.14. 8.15.0.
12	227,760	1.11.12.12.0.	52	986,960	6.17. 1.10.0.
13	246,740	1.14. 5. 7.0.	53	1,005,940	6.19.14. 5.0.
14	265,720	1.16.18. 2.0.	54	1,024,920	7. 2. 7. 0.0.
15	284,700	1.19.10.15 0.	55	1,043,900	7. 4.19.13.0.
16	303,680	2. 2. 3.10.0.	56	1,062,880	7. 7.12. 8.0.
17	322,660	2. 4.16. 5.0.	57	1,081,860	7.10. 5. 3.0.
18	341,640	2. 6. 9. 0.0.	58	1,100,840	7.12.17.16.0.
19	360,620	2. 9. 1.13.0.	59	1,119,820	7.15.10.11.0.
20	379,600	2.12.14. 8.0.	60	1,138,800	7.18. 3. 6.0.
21	398,580	2.15. 7. 3.0.	61	1,157,780	8. 0.16. 1.0.
22	417,560	2.17.19.16.0.	62	1,176,760	8. 3. 8.14.0.
23	436,540	3. 0.12.11.0.	63	1,195,740	8. 6. 1. 9.0.
24	455,520	3. 3. 5. 6.0.	64	1,214,720	8. 8.14. 4.0.
25	474,500	3. 5.18. 1.0.	65	1,233,700	8.11. 6.17.0.
26	493,480	3. 8.10.14.0.	66	1,252,680	8.13.19.12.0.
27	512,460	3.11. 3. 9.0.	67	1,271,660	8.16.12. 7.0.
28	531,440	3.13.16. 4.0.	68	1,290,640	8.19. 5. 2.0.
29	550,420	3.16. 8.17.0.	69	1,309,620	9. 1.17.15.0.
30	569,400	3.19. 1.12.0.	70	1,328,600	9. 4.10.10.0.
31	588,380	4. 1.14. 7.0.	71	1,347,580	9. 7. 3. 5.0.
32	607,360	4. 4. 7. 2.0.	72	1,366,560	9. 9.16. 0.0.
33	626,340	4. 6.19.15.0.	73	1,385,540	9.12. 8.13.0.
34	645,320	4. 9.12.10.0.	74	1,404,520	9.15. 1. 8.0.
35	664,300	4.12. 5. 5.0.	75	1,423,500	9.17.14. 3.0.
36	683,280	4.14.18. 0.0.	76	1,442,480	10. 0. 6.16.0.
37	702,260	4.17.10.13.0.	77	1,461,460	10. 2.19.11.0.
38	721,240	5. 0. 3. 8.0.	78	1,480,440	10. 5.12. 6.0.
39	740,220	5. 2.16. 3.0.	79	1,499,420	10. 8. 5. 1.0.
40	759,200	5. 5. 8.16.0.	80	1,518,400	10.10.17.14.0.